PTO 04-1177

CY=EP DATE=19840523 KIND=A
PN=1,094,088

CURRENT LIMITER
[TOKOOGRANICHITEL']

L.T. Nikolayeva, et al.

UNITED STATES PATENT AND TRADEMARK OFFICE
Washington, D.C. DECEMBER 2003

Translated by: FLS, Inc.

PUBLICATION COUNTRY	(10):	USSR
DOCUMENT NUMBER	(11):	1.094,088
DOCUMENT KIND	(12):	USSR Author's Certificate
PUBLICATION DATE	(43):	19840523
PUBLICATION DATE	(45):	
APPLICATION NUMBER	(21):	3554968/24
APPLICATION DATE	(22):	19830218
ADDITION TO	(61):	
INTERNATIONAL CLASSIFICATION	(51):	H 01 H 87/00
DOMESTIC CLASSIFICATION	(52):	
PRIORITY COUNTRY	(33):	
PRIORITY NUMBER	(31):	
PRIORITY DATE	(32):	
PRIORITY COUNTRY	(33):	
PRIORITY NUMBER	(31):	
PRIORITY DATE	(32):	
PRIORITY DATE	(32):	
DESIGNATED CONTRACTING STATES	(84):	
INVENTORS	(72)	L.T. Nikolayeva, et al.
APPLICANT	(71):	Kuybyshevskiy ordena Trudovogo Krasnogo Znameni politekhnicheskiy institut im. V.V.Kuybysheva
TITLE	(54):	Current Limiter
FOREIGN TITLE	(54A):	Tokoogranichitel'

(54) CURRENT LIMITER

(57) Abstract

A current limiter is disclosed that contains a body, two solid metal electrodes, insulation plates, in each of which capillary cross section openings are made, which form capillary channels, while the insulation plates separate the inter-electrode space into cylindrical cavities, partially filled with liquid metal, and the channels are positioned coaxially with respect to the cylindrical cavities, characterized in that in order to increase the nominal current, ensuring the possibility of operation during revolutions about the horizontal axis by 360° and inclinations of 45-50° relative to the vertical plane, it is equipped with partitions, which are made of current-conducting material, the aforementioned partitions are installed in cylindrical cavities parallel to the insulation plates in such a manner that they extend from the body to the outside, and additional capillary cross section openings are made in the insulation plates, whereby all openings of each insulation plate are located symmetrically on the periphery.

The invention pertains to electrical equipment, in particular to continuously operating current limiters, and it can be used in highly accurate protection circuits.

Liquid metal current limiters, whose operating principle is based on evaporation of the liquid metal enclosed in a capillary channel [1] and [2], are known.

Disadvantages of the indicated devices are low reliability, limited nominal current and operation in a fixed position.

A current limiter that contains solid metal electrodes, separated by an insulation chamber, made with a capillary section channel filled with liquid metal is also known.

The nominal current is limited by the cross section of the capillary channel. During flow of a short circuit current the Joule

heat released leads to evaporation of the liquid metal and creation of high pressure in the channel. A plasma is formed that has large specific resistance, which leads to the current limiting effect [3].

However, in order to manufacture such current limiters materials are needed, which withstand without destruction a pressure on the order of 100-200 atmospheres, and moreover, devices of such design are unstable in operation and do not last long.

Closest in technical embodiment to the proposed device is a current limiter that contains solid metal electrodes, separated by an insulation chamber, equipped with a series of insulation partitions with capillary cross section channels, which form between themselves cylindrical cavities with cross section greater than the capillary channel, partially filled with liquid metal, while the indicated cavities are located in non-coaxial manner with the capillary section channel, by means of which they are in communication with one another [4].

A disadvantage of the existing device is that the temperature gradient of the current limiter lengthwise in nominal mode is not uniform. The extreme and central cylindrical cavities, filled with liquid metal, are found under different conditions, because the extreme spaces are adjacent to the solid metal leads that are usually made of copper, which has a large coefficient of heat conductivity in comparison with the liquid metal:

(λ_{copper} = 3.9 x 10^2 w/m x degrees;

eutectic λ = 0.376 x 10^2 W/m x degrees,

which allows one to use them for discharge of the heat released in the current limiter. In this case, the removal of heat from the central cavities into the copper is made difficult, because they are in contact with one another through the insulation partitions, which have narrow channels filled with liquid metal. This leads to greater heating of the liquid metal in the central cylindrical cavities, which limits the nominal current.

Another disadvantage of the existing current limiter is operation in horizontal position, which limits the range of application.

The aim of the invention is to increase the nominal current for the same structural dimensions by improving the heat removal along the entire length of the current limiter by current-conducting partitions and reducing the resistance of the conductor of the device, and also the possibility of its operation during revolutions about the horizontal axis by 360° and inclinations of 45-50° with respect to the vertical plane.

The indicated goal is achieved by the fact that the current limiter, which contains housing, two solid metal electrodes, insulation plates, in each of which capillary cross section openings are made, form capillary channels, while the insulation plates separate the inter-electrode space into cylindrical cavities,

partially filled with liquid metal, and the channels are positioned non-coaxially with respect to the cylindrical cavities, equipped with partitions made of current conducting material, the indicated partitions are installed in the cylindrical cavities parallel to the insulation plates in such a way that they extend from the housing to the outside, and in the insulation plates additional openings are made that have capillary cross section, whereby all openings of each insulation plate are located symmetrically on the periphery.

During rotations of the device by 360° about the horizontal axis additional capillary cross section channels will be sunk into the liquid metal, located symmetrically on the periphery, without changing their number, therefore the structure remains serviceable regardless of the rotational angle about the horizontal axis, the rotational angle relative to the vertical plane can be up to 45-50° due to the presence of current conducting partitions in the cylindrical spaces, which make them non-communicating with one another over the entire length of the current limiter.

Figure 1 shows the current limiter in general view, Figure 2 shows the A-A section of Figure 1.

The current limiter contains solid metal electrodes **1** and **2**, insulation ceramic plates **3**, in which capillary section openings **4** are made symmetrically on the periphery, as are copper partitions **5**, whose surfaces project to the outside of the current limiter into the surrounding medium.

Components **1**, **2**, **3** and **5** are separated from one another by insulation plates **6**, thereby forming cylindrical cavities **7**. The entire structure of the current limiter is secured by the insulated pin **8**. The cylindrical cavities **7** are partially filled with liquid metal **9**, and the working openings **4** of the capillary section for the given position of the current limiter are also filled with liquid metal.

The current limiter works in the following way.

With the circuit closed the liquid metal **9** fills the capillary section openings **4** and cylindrical cavities **7**. When the current increases above the acceptable level there is explosion of the liquid metal **9** in the working openings **4** of the capillary section, the pressure increases suddenly, due to the action of which vapors of liquid metal will be sprayed into the cylindrical cavities **7** and, passing through the liquid metal space found in them, is cooled and concentrated. The copper partitions **5** promote better cooling, which remove the heat to the outside and level the temperature along the length of the current limiter. Deflection arcs that occur in this case in the capillary channels have reference spots in the liquid metal, which is found in the large cross section cavities **7**. Ceramic surfaces of the capillary section openings **4** in this case are cooled due to the rapid removal of electric arc thermal energy flow by liquid metal in cavities **7** and the copper partitions **5**.

The current limiter can operate during rotation about the horizontal axis of 360°, because in this case the number of capillary cross section openings **4**, sunk into the liquid metal **9**, remains unchanged even for inclinations relative to the vertical plane by the angle 45-50°, because the copper partitions create liquid metal cavities that do not communicate lengthwise.

Thus, the advantages of the proposed current limiter consist in increasing the nominal current without increasing the dimensions of the structure and in the possibility of operation during rotations about the horizontal axis of 360° and for inclinations relative to the vertical plane of 45-50°, which expands the area of its application.

Current limiter of this design can be used in powerful ship electric power generation systems (EES).

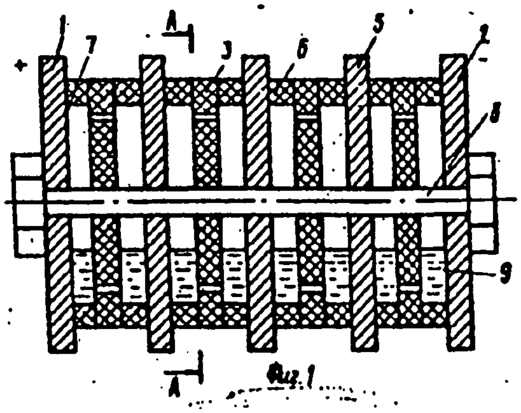

Figure 1

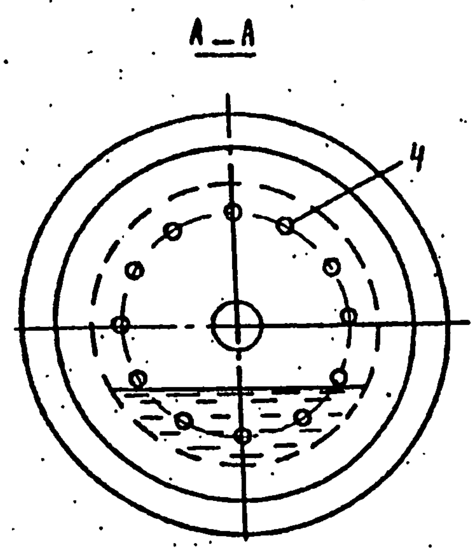

Figure 2